REMARKS

Claims 1-9, 12, 18-21 and 23 are pending in this application.

Claims 1-9, 12, 18-21 and 23 are rejected.

In the non-final office action dated June 18, 2003, claim 1 is rejected under 35 USC §103(a) as being unpatentable over Parkin U.S. Patent No. 5,966,012 in view of Lin U.S. Patent No. 5,949,623; claim 7 is rejected under 35 USC §103(a) as being unpatentable over Parkin in view of Dahlberg 6,166,539; and claim 18 is rejected under 35 USC §103(a) as being unpatentable over Parkin in view of Lin, Monsma U.S. Patent No. 6,269,018 and Gallagher U.S. Patent No. 5,640,363. These rejections are respectfully traversed.

'103 rejection of claim 1

Claim 1 recites a magnetic tunnel junction comprising a data layer having a magnetization that can be oriented in first and second directions; a synthetic ferrimagnet reference layer; and an insulating tunnel barrier between the data layer and the reference layer. The reference layer is not pinned.

Parkin discloses a magnetic tunnel junction (MTJ) including reference layers that are pinned. See col. 6, lines 1+, where Parkin discloses a reference layer 118 having a magnetization that is fixed by an AF pinning layer 116, and a sense layer 132 atop the reference layer 118.

The pinned layer 118 has a magnetization orientation that is fixed so as not to rotate in the presence of an applied magnetic field in a range of interest. The sense layer 132 has a magnetization that can be oriented in either of two directions: the same direction as the pinned layer magnetization or the opposite direction of the pinned layer magnetization. If the magnetizations of the pinned and sense layers 118 and 132 are in the same direction, the orientation of the

MTJ is said to be "parallel." If the magnetizations of the pinned and sense layers are in opposite directions, the orientation of the MTJ is said to be "anti-parallel." These two stable orientations, parallel and anti-parallel, may correspond to logic values of '0' and '1.'

These logic values may be read by sensing the resistance of the MTJ. The MTJ has a nominal resistance R when its magnetization orientation is parallel, and a higher resistance of $R+\Delta R$ when its magnetization orientation is anti-parallel.

Lin discloses anisotropic magnetoresistive (AMR) and giant magnetoresistive (GMR) sensors. Both a GMR device and an AMR device include a sense layer and reference layer separated by a spacer layer made of an electrically conductive material such as copper. Although primarily disclosing reference layers with pinned magnetizations, Lin does mention at col. 1, lines 36-38 that the reference layer of an AMR device may generate a transverse bias field by activation from the current supplied to the sensor.

However, this one passage does not suggest that the reference layer of a magnetic tunnel junction can be unpinned. An AMR device has a different structure than a magnetic tunnel junction (e.g., an electrically conductive spacer layer versus an insulating tunnel barrier) and its resistance is measured differently during read operations (in-plane resistance[1] versus through-plane resistance[2]).

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1 During a read operation on an AMR device, a voltage is applied across opposite ends of a data layer, whereby a sense current flows from one end of the data layer to the other end. The sense current is proportional to the resistance from the one end of the data layer to the other. The sense current does not flow through the spacer layer or the reference layer. Thus the resistance and the sense current of the AMR device are in-plane. The in-plane resistance is affected by the relative magnetization orientations of the data and reference layers.

2 During a read operation on a magnetic tunnel junction, a voltage is applied across the data and reference layers, whereby a sense current tunnels through the insulating tunnel barrier. The sense current is proportional to the resistance across the insulating tunnel barrier. Thus the resistance and the sense current are through-plane. The tunneling and through-plane resistance are affected by the relative magnetization orientations of

Lin does not describe the structure of an unpinned reference layer, does not describe its operation, and does not describe any specific understanding or principle behind unpinned reference layers in AMR devices, let alone magnetic tunnel junctions. Lin does not explain how an unpinned reference layer can be used in different magnetoresistive devices, particularly magnetic tunnel junctions. Lin does not teach or suggest how to determine the magnetization orientation (whether parallel or anti-parallel) of a magnetic tunnel junction if the magnetization vector of the reference layer is not fixed. In general, Lin offers no reason, motivation or incentive for modifying the reference layer of Parkin's magnetic tunnel junction.

See MPEP 2143.01 regarding incentive or motivation to modify references. According to MPEP 2143.01, "[t]he mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. In re Mills, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990).

The '103 rejection is a classic example of hindsight reconstruction of the claimed invention. The examiner is using applicants' structure as a template and selecting elements from the cited documents to fill the gaps. However, such hindsight reconstruction does not provide a legal basis for a '103 rejection. Therefore, the '103 rejections of claim 1 and its dependent claims 2-6, 9 and 12 should be withdrawn.

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the data and reference layers. Resistance of a typical MTJ is orders of magnitude greater than the resistance of a typical AMR device.

'103 rejection of claim 7

Claim 7 recites a magnetic memory device including a data layer, and a synthetic ferrimagnet reference layer, the data and reference layers having different coercivities. Claim 7 further recites a first conductor on the reference layer; an electrical insulator on the first conductor; and a second conductor on the insulator. The second conductor may be used to set the magnetization orientation of the reference layer during read operations.

Thus claim 7 recites a means (the second conductor) for operating a magnetic tunnel junction having an unpinned reference layer. Neither Parkin or Dalhberg et al. teach or suggest such means. Therefore, claim 7 and its dependent claim 8 should be allowed over Parkin and Dahlberg et al.

The examiner contends that it would be obvious to modify Parkin's magnetic tunnel junction by placing a first conductor on Parkin's reference layer, an electrical insulator on the first conductor; and a second conductor on the insulator.

Parkin shows first and second layers of conductors 102 and 112. According to col. 5, lines 66+ of Parkin, a seed layer 112 is formed on an electric conductor 102. The seed layer 112 is used to establish a crystal orientation for the overlying pinning layer 116. The passage does not teach or suggest a layer between the seed layer 112 and the conductor 102, and Figure 4a of Parkin does not show any layer between layers 102 and 112.

During a read operation, through-plane resistance of the TMR device is measured, that is, resistance is measured between conductor 102 and a top electrical lead 104. Placing an insulator between layers 102 and 112 would

prevent the through-plane resistance from being measured. Consequently, the magnetic tunnel junction would be rendered unusable for its intended purpose.

MPEP 2143.01 states that the proposed modification cannot render the prior art unsatisfactory for its intended purpose. Since the modification proposed by the examiner would render Parkin's MTJ unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification.

'103 rejection of claim 18

Claim 18 recites an information storage device including a plurality of magnetic tunnel junctions. Each magnetic tunnel junction includes a data layer and a soft ferrimagnet reference layer. Only the reference layer is switchable between first and second directions during a read operation on a selected magnetic tunnel junction.

Parkin, Gallagher and Monsma all disclose magnetic tunnel junctions having pinned reference layers. The reference layer is pinned so it does **not** switch during read operations. In fact, neither the data layer nor the reference layer is switched during read operations. If either layer was switched, data would be lost.

As indicated above, Lin provides a single passage about unpinned reference layers. This passage does not teach or suggest a reference layer that is switchable between first and second directions during a read operation. Therefore, the office action has not taught or suggested all of the limitations of claim 18.

According to MPEP 2143.03, all claim limitations must be taught or suggested in the prior art; otherwise prima facie obviousness is not established. Because none of Parkin, Gallagher, Monsma and Lin teach or suggest a magnetic tunnel junction having a reference layer that is switchable during read operations, the office action has not established prima facie obviousness of claim 18. Accordingly, the '103 rejection of claim 18 and its dependent claims 19-21 and 23 should be withdrawn.

Response to examiner's comments in latest office action

The undersigned reviewed the section entitled Response to Arguments. Quite frankly, the undersigned does not understand what the examiner is responding to when he mentions the inclusion of the tunnel barrier layer, and allusions to the possibility that Lin is non-analogous art.

The undersigned does not understand how or why "Applicant misconstrues his own concept of 'unpinned reference layer' when alleging that neither Parkin or Lin teach or suggest how to determine the magnetization orientation of a magnetic tunnel junction having an unpinned layer."[3] Rather than accuse the applicant of misconstruing his own invention, it would be much more helpful to cite the exact passages where Parkin or Lin discuss read operations. Thus far, the examiner has not.

The undersigned has also reviewed the grounds for the '103 rejections. The following statements were made by the examiner.

1. Parkin does not necessarily disclose a synthetic ferrimagnetic reference

3 The examiner cites paragraph 22 of the specification, which states "reference layer 14 has a magnetization (represented by the vector M2) that can be oriented in first and second directions, typically along its easy axis (EA2)."

layer that is unpinned (Paragraph 1).

2. "It is understood in the art of magnetic resonance that reference layers can generate the required traverse bias field, a generic function for all reference layers in all types of magnetic resonance sensors in the prior art as cited" (Paragraph 1).

3. Motivation for combining the references (replacing the pinned layer with an unpinned layer) is "obviating the need for the additional energy expanded for the pinning" (Paragraph 1).

4. "Combination of the inventions (Parkin and Lin) is easily accomplished through the judicious selection of material in view of the required coercivity and the mere removal of the pinning layer. Success in implementing the combination can therefore be reasonably expected" (Paragraph 1).

5. "[I]t has long been taught in the art to provide an intermediate insulation layer in between the conductor for providing the current needed to orient the magnetization in the reference layer and the cap layer 112 in order to reduce the influence of temperature through ohmic heating on magnetization of said reference layer." (Paragraph 2).

6. The reference layer of Parkin is being switchable during reading operations through passing a current through sense or access line 104 (Paragraph 5).

7. "None of the above cited two references [Parkin, Lin, Monsma, or Gallagher] necessarily teach the further limitation that 'only' the second layer be so switchable, however, evidently one is enough, and hence, for the reasons of

economy, two would be a waste" (Paragraph 5),

The undersigned will now respond to these statements. In statement (1), the phrase "does not necessarily" is unclear and confusing. Either Parkin discloses an unpinned reference layer, or it does not. The undersigned and the applicants have reviewed Parkin and see no teaching or suggestion of an unpinned reference layer.

Statements (2), (3), (5) and (7) are not found in any of the cited documents and, therefore, are presumed to be within the personal knowledge of the examiner. Pursuant to MPEP §707 and 37 CFR §1.104(d)(2), the examiner is respectfully requested to cite a document or affidavit supporting his personal knowledge.

Statement (4) is irrelevant. The issue is not whether a proposed modification can be made, but whether Lin provides the incentive or motivation for making the proposed modification.

Regarding statement (6), the undersigned has reviewed Parkin and did not find a statement about a reference layer being switchable during read operations. The examiner is respectfully requested to cite the column and line number supporting Statement (6).

Supplemental IDS

A supplemental IDS is being filed with this amendment. Assignee's U.S. Patent Nos. 6,576,969 and 6,538,917 should be made of record.

Conclusion

The Examiner is respectfully requested to withdraw the rejections and issue a notice of allowability. If any issues remain, the Examiner is invited to contact the undersigned.